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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/881,408	06/13/2001	Kie Y. Ahn	M122-1534	8492
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WELLS ST. JOHN P.S. 601 W. FIRST AVENUE, SUITE 1300 SPOKANE, WA 99201				
EXAMINER LE, THAO X				
ART UNIT		PAPER NUMBER		
2814				

DATE MAILED: 11/19/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/881,408

Applicant(s)

AHN ET AL

Examiner

Thao X Le

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-- The MAILING DATE of this communication appears on the cover sheet with correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 26 September 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-31, 52 and 54-59 is/are pending in the application.
- 4a) ☐ Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 56-59 is/are allowed.
- 6) ☒ Claim(s) 1-9, 13-27, 29-31 and 52-55 is/are rejected.
- 7) ☒ Claim(s) 10-12 and 28 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 0903.
- 4) ☐ Interview Summary (PTO-413) Paper No(s): _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Acknowledgement

1. Applicant's cancellation of claims 32-51 and 53 in Paper No. 0903 is acknowledged

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1-4, 6-8, 13-15, 18-20, 23-26, 29-31, 52, 54 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pub 2001/0013629 to Bai in view of US 6573197 to Callegari et al.

Regarding to claims 1, 19, 25 Bai discloses in fig. 1 a method of forming a dielectric layer comprising: a substrate 105 comprising a silicon-containing surface, forming a first metal-containing dielectric layer 130 consisting of metal oxide [0018] over the surface, all the metal comprising of the first dielectric layer consisting of at least one element selected from group IVB of the periodic table, and forming a second metal-containing dielectric layer 120 on and in contact with the first metal-containing dielectric layer 130, consisting of metal oxide.

But Bai does not disclose all the metal of the second dielectric layer consisting of at least one element selected from Group IIIB of the periodic table.

However, Callegari discloses the high dielectric layer 14 in fig. 3 can be La_2O_3 , BST or PZT, column 4 lines 47-67. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to replace the BST layer 120 of Bai with La_2O_3 layer 14 teaching of Callegari with Bai, because such material substitution would have considered a mere substitution of art-recognized equivalent values.

Regarding to claims 2, 4, Bai teaches the first metal-containing dielectric layer 130 consists of hafnium [0018] and wherein the second metal-containing dielectric layer 120 consists of BST or PZT [0019].

Regarding to claims 6-7, Bai does not disclose the second metal-containing dielectric layer consists an element selected from group IIIB of the periodic table, and wherein the second metal-containing dielectric layer consists of lanthanum.

But Callegari reference Callegari discloses the metal-containing dielectric layer 14 consists an element selected from group IIIB of the periodic table,

wherein the metal-containing dielectric layer consists of lanthanum oxide, BST or PZT, column 4 lines 47-67. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the lanthanum oxide teaching of Callegari to replace BST dielectric of Bai, because such material substitution would have considered a mere substitution of art-recognized equivalent values.

Regarding to claims 8, 24-26, Bai discloses the method wherein forming of the first metal-containing dielectric and the forming of the second metal-containing dielectric layer comprise: forming a hafnium-containing layer 130, forming a metal-containing layer 130, over the hafnium-containing layer, and

But Bai does not disclose forming a lanthanum-containing layer over the hafnium-containing layer, and exposing the hafnium-containing layer and lanthanum-containing layer to a oxygen comprising atmosphere, and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

But Callegari reference discloses the perovskite type dielectric can be replace with lanthanum-containing layer as discussed in the above claims 1 and 6-7, and exposing the hafnium-containing layer and lanthanum-containing layer to a oxygen comprising atmosphere, and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature about 350°C-750°C effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer, column 2 line 50-65. At the time the invention was made; it would have been

obvious to one of ordinary skill in the art to combine the teaching of Callegari with Bai, because it would have produced a thermally stable polysilicon/high-k dielectric stack as taught by Callegari, see Abstract.

Regarding to claims 13-15, 18, 29-31, Bai does not disclose the ratio of the hafnium thickness to the lanthanum thickness of about 1 to 3 to about 1 to 4, from about 4:1 to about 1:4.

But Bai discloses various thickness of layer 120 and 130 in Table I. Accordingly, it would have been obvious to one of ordinary skill in art to use the teaching of Ota in the range as claimed, because it has been held that where the general conditions of the claims are disclosed in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation. See *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955).

Regarding to claims 20, 52, 54, 55 as discussed in the above claim 1 Ota and Callegari discloses all the limitation of claim 20 including forming a MOS transistor in fig. 1 comprising a gate electrode 110 over the hafnium-containing and lanthanum-containing dielectric layers.

Regarding claim 23, Bai does not disclose forming a silicon dioxide layer over a portion of the surface comprising silicon, prior to forming of the hafnium-containing dielectric layer.

But Callegari reference discloses forming a silicon dioxide layer 12, fig. 2, over a portion of the surface comprising silicon, prior to forming of the hafnium-containing dielectric layer 14, fig. 3. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to combine the teaching of

Callegari with Bai, because it would have produced a thermally stable polysilicon/high-k dielectric stack as taught by Callegari, see Abstract.

Regarding claim 3, as discussed in the above claims 1, 23 and 26, Bai and Callegari disclose all the limitation of claim 3.

4. Claims 5, 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pub. 2001/0013629 to Bai and US 6573197 to Callegari and 84,072 and further in view of US 6184072 to Kaushik et al.

Regarding to claim 5, 27, Bai and Callegari do not expressly disclose the method further comprising chemically reduce the layer of silicon dioxide layer.

But Kaushik reference discloses the silicon oxide layer 14, fig. 1, column 2 line 60, hafnium metal layer 16, fig. 2, column 2 line 47 and column 3 line 2, over the layer of the silicon dioxide; and combining metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material 18, fig. 3, column 3 line 13-30. At the time of the invention was made; it would have been obvious to one of ordinary skill in the art to use the teaching of Kaushik with Bai method, because it would have created a high-K dielectric layer as taught by Kaushik, column 3 line 28 (the formation of layer 18 would have chemically reduced the silicon dioxide layer).

5. Claims 9, 16-17, 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Pub. 2001/0013629 to Bai and US 6573197 to Callegari and 84,072 and further in view of US Patent 6,399,521 to Zhang et al.

Regarding to claims 9, 16-17, 21-22, Callegari discloses the gate dielectric is deposited by conventional techniques such as CVP, column 5 line 66. In addition, Zhang

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discloses the CVP, PVD, & MOCVD processes to deposit hafnium containing layer 14 fig. 3, column 5 line 51. At the time of the invention was made; it would have been obvious to one of ordinary skill in the art to select the deposition process as disclosed above, because such processes have been commonly used in the art and can be used interchangeably.

Response to Arguments

6. Applicant's arguments with respect to claims 1-31, 52, 54-59 have been considered but are moot in view of the new ground(s) of rejection.

Allowable Subject Matter

7. Claims 10-12, and 28 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

- With respect to claim 10, the prior art of record fails to disclose all the limitation in claim 10, including the exposing comprises ion bombardment of the hafnium layer and the lanthanum-containing layer using and ion bombardment energy of about 10 EV or less.
- With respect to claim 11, the prior art of record fails to disclose all the limitation in claim 11, including the heating comprises heating the temperature from about 200°C to about 400°C during the ion bombardment.
- With respect to claim 12, the prior art of record fails to disclose all the limitation in claim 12, including the exposing to oxygen radicals.

- With respect to claim 28, the prior art fails to disclose all the limitations in claim 28, including providing ion bombardment of the hafnium layer and the lanthanum-containing layer using and ion bombardment energy of about 10 EV or less and where the heating to an effective temperature comprises heating while providing ion bombardment to a temperature from about
8. Claims 56-59 are allowed.
- With respect to claim 58, the prior art fail to discloses all the limitation of the base claim 58 including exposing hafnium-containing layer and the lanthanum-containing layer to oxygen radicals within the reaction chamber and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.
 - With respect to claims 56 and 59, the prior art fails to disclose all the limitations of the base claims 56 and 59 including exposing the hafnium-containing layer and the lanthanum-containing layer to an oxygen comprising atmosphere by ion bombardment using an energy of about 10 eV or less.

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thao X Le whose telephone number is 703-306-0208. The examiner can normally be reached on M-F from 8:00 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M Fahmy can be reached on 703-308-4918. The fax phone number for the organization where this application or proceeding is assigned is 703-308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Thao X. le
06 Nov. 2003



THAO X. LE
EXAMINER